UNCLASSIFIED
Security Classification

AD-739589

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY *(Corporate author)*
U.S. Army Test and Evaluation Command
Aberdeen Proving Ground, Maryland 21005

2a. REPORT SECURITY CLASSIFICATION
Unclassified

2b. GROUP

3. REPORT TITLE
U.S. Army Test and Evaluation Command System Engineering Test Operations Procedure - "Earth Loading Equipment."

4. DESCRIPTIVE NOTES *(Type of report and inclusive dates)*
Final

5. AUTHOR(S) *(First name, middle initial, last name)*

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
9 March 1972	13	12

8a. CONTRACT OR GRANT NO.	9a. ORIGINATOR'S REPORT NUMBER(S)
b. PROJECT NO.	TOP 9-2-071
c. AMCR 310-6	9b. OTHER REPORT NO(S) *(Any other numbers that may be assigned this report)*
d.	

10. DISTRIBUTION STATEMENT
Approved for public release; distribution unlimited.

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
	Headquarters U.S. Army Test and Evaluation Command Aberdeen Proving Ground, Md. 21005

13. ABSTRACT

Describes a method for evaluation of earth loading equipment operational and functional performance characteristics. Identifies supporting tests, facilities, and equipment required. Provides procedures for safety, functional performance, loading, and capacity rating to include tables establishing minimum performance standards.

DD FORM 1 NOV 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

UNCLASSIFIED
Security Classification

14. KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Backhoe						
Bucket-Clamshell						
Earth Loading Equipment						
Elevator (Bucket-Type)						
Loaders						
Shovels						

U.S. ARMY TEST AND EVALUATION COMMAND
SYSTEM ENGINEERING TEST OPERATIONS PROCEDURES

AMSTE-RP-702-108
Test Operations Procedure 9-2-071

9 March 1972

EARTH LOADING EQUIPMENT

		Paragraph	Page
Section I.	GENERAL		
	Purpose and Scope	1	1
	Background	2	1
	Equipment and Facilities	3	2
II.	TEST PROCEDURES		
	Supporting Tests	4	2
III.	SUPPLEMENTARY INSTRUCTIONS		
	Safety	5	4
	Functional Performance	6	4
	Loading Test	7	5
	Capacity Rating (Front End Loader)	8	10
APPENDIX.	REFERENCES		13

SECTION I
GENERAL

1. Purpose and Scope. This TOP describes test procedures for evaluating the operational and performance characteristics of earth loading equipment. Equipment covered includes: bucket type inclined elevating conveyors, crane attachments and belt, bucket and scoop loaders. From the tests listed in Section II, the test director can select those that will satisfy the requirements for the particular test item and the particular test type (i.e., engineering test, initial production test, etc.). Test objectives are to determine conformance of the test items to QMR, MN or other suitability criteria. For initial production tests, scope will be in accordance with the contractual provisions of the applicable military specifications and suitability criteria established by the test directive. Environmental tests, as dictated by the size and nature of the test item, may require use of components or sample sections of materials as well as on-site climatic tests.

2. Background. Military operations, especially those concerned with the construction of highways, airfields and foundations, require a capability to load and move large quantities of earth in relatively short periods of time. Loading is accomplished by mechanical earth loading equipment including crane attachments, bucket-type inclined elevating conveyors, and belt, bucket and scoop loaders. A basic

crane can be converted to provide earth pickup and loading capabilities by addition of either a clamshell bucket, dragline, hoe or a shovel. For attachments which are crane-operated, reference should be made to TOP 9-2-057. Description of attachments and other terms may be found in Commercial Standard CS 90-58, Power Cranes and Shovels. An inclined elevating conveyor modified with a series of buckets can provide like capabilities. Belt, bucket and scoop loaders are special purpose vehicles equipped with either a belt conveyor or a boom using specially designed buckets or scoops for pickup and loading.

3. Equipment and Facilities. Equipment and facilities required are defined in the documents listed in Section II.

SECTION II
TEST PROCEDURES

4. Supporting Tests. Subtests (generally in preferred order of completion with respect to high-risk, short duration) to be considered in formulating a test plan are listed below with references.

	TEST SUBJECT TITLE	PUBLICATION NO.
a.	Pre-operational Inspection	10-3-500
(1)	Operator Training and Familiarization	10-2-501
(2)	Photographic Coverage	7-3-519
b.	Physical Characteristics	10-2-500
(1)	Magnetic Particle Test	MIL-STD-271D Para 4
(2)	Liquid Penetrant	Para 5
c.	Safety (Refer to para 5)	10-2-508 2-2-508
d.	Performance	
(1)	Crane	9-2-057
(2)	Crane Attachments (Clamshell bucket, dragline, hoe and shovel) Functional Performance (Refer to para 6)	
(3)	Elevator, Bucket Type	
(a)	Loading Test (Refer to para 7)	
(b)	Conveyor Equipment	9-2-046
(4)	Loaders	
(a)	Belt	MIL-L-14554B Para 4.6.2
(b)	Bucket	MIL-L-403D Para 4.5.2

TEST SUBJECT TITLE	PUBLICATION NO.
(c) Scoop	MIL-L-52385B Para 4.6.2, Appendix
(d) Capacity Rating (Front End Loader) (Refer to para 8)	SAE J742a
(5) Associated Vehicles	2-2-500
e. Environmental Tests	
(1) Temperature	MIL-STD-810B Method 501 AR 70-38
(2) Low Temperature Storage	MIL-L-52385B Method 13
(3) Sunshine	4-2-826
(4) Rain	2-2-815
(5) Humidity	4-2-820
(6) Salt Fog	MIL-STD-810B Method 509
(7) Dust	Method 510
(8) Vibration	4-2-804
(9) Electromagnetic Interference Characteristics	MIL-STD-461A Notice 4 MIL-STD-462 Notice 3 Method RE05
f. Transportability	
(1) Road, Rail, Marine	10-2-503
(2) Air	7-2-515
g. Human Factors Evaluation Sound Levels	10-2-505 HEL-STD S-1-63B
h. Reliability Confidence Intervals and Sampling Size	AMCP 702-3 3-1-002
i. Durability (Endurance Testing)	10-2-502
j. Maintenance Evaluation	10-2-507
k. Value Analysis	USAMC SUPPL 1 to AR 11-26

SECTION III
SUPPLEMENTARY INSTRUCTIONS

5. Safety. The applicable QMR, MN or specification is carefully reviewed for safety criteria. Certification of safety aspects determined during construction or pre-production tests are obtained from the developer and accepted where valid. All personnel, including operators, are made thoroughly familiar with all safety procedures and requirements of the test item prior to test operations. Maximum precautions are taken during stability, overload, boom topping and slewing and other safety critical phases. Proper performance of the crane during these operations is assured by using experienced personnel during pretest operations. In addition to MTPs 2-2-508 and 10-2-508 and test item technical manuals, documents such as the following are reviewed for applicability:

AMC Safety Manual 385-100

MIL-STD-882, "Systems Safety Program for Systems and Associated Subsystems and Equipment."

American National Standards Institute, Inc. (ANSI),
B30.2.0-1967, "Overhead and Gantry Cranes."
B30.5-1968, "Crawler, Locomotive and Truck Cranes."
B30.6-1969, "Derricks, Safety Code for."

National Safety Council Data Sheets,
D-271, "Operation of Power Shovels, Dragline and Similar Equipment."
D-380, "Wire Rope, Safe Loads for Slings."
No. 130, "Safe Use of Heavy Duty Equipment on Construction Jobs."

Power and Crane Shovel Association, "125 Ways to Better Power Shovel-Crane Operation."

Underwriters' Laboratories, UL 558, "Standards for Safety for Power Operated Industrial Trucks."

6. Functional Performance.

a. Objective. To determine the adaptability, effectiveness and suitability of the test item to be assembled and used as a crane attachment.

b. Method. The technical manual instructions are used by the designated crew to assemble the test item and properly reeve all cables to the crane. The assembled test item is used to load specified

quantities of material into a truck or hopper for a specified number of cycles of operation or period of time. Trained test personnel observe and record comments concerning the capability of the test item to be readily assembled, handled and disassembled; ease of assembling leads; need for modifications or adaptors; difficulties in reeving and connecting lines; adequacy of fairleads and alinement; compatibility of test item and ability to perform mission tasks.

c. Data Required.

(1) Nomenclature and type of test item.

(2) Type and configuration of test material used.

(3) Published performance data (Tables 1 thru 4).

(4) Time and manhours required to assemble test item.

(5) Observations on ease and adequacy of assembly.

(6) Difficulties or modifications required.

(7) Task performance data: type and quantity of material moved, operating time, acceptability.

d. Analytical Plan. Observed and collected data are compared with the criteria of the requiring documents and tables 1 thru 4 to determine conformance to specifications.

7. Loading Test.

a. Objective. To determine the capability of the test item to provide minimal loads at specified discharge heights.

b. Method. A suitable test area containing stockpiled earth, sand, gravel or other comparable material is prepared and bins or dump trucks are provided to receive and measure the material discharged from the test item. The test item, operated by experienced equipment operators, is used to load the test material into the bins or dump trucks. The loading is performed in specified cycles of operation or time whichever is most appropriate for the equipment being tested. The total quantity of test material loaded into the bins or trucks is measured and identified by discharge height used. The loading and measuring procedure is repeated for each specified discharge height.

c. Data Required.

(1) Nomenclature and description of test item.

Table 1. Power Shovel and Dragline Output

90° SWING—60-MINUTE HOUR

Upper figures represent power shovel. Lower figures represent dragline.

Dipper or Bucket Cap. in Cu. Yd.	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/2	2 3/4	3	3 1/2	4	4 1/2	5	5 1/2	6
Moist Loam or	165	205	250	285	320	355	405	435	465	525	580	635	685	740	795
Light Sandy Clay	130	160	195	220	245	265	305	...	350	390	465	...	540	...	610
Sand and	155	200	230	270	300	330	390	420	450	505	555	600	645	695	740
Gravel	125	155	185	210	235	255	295	...	340	380	455	...	530	...	600
Good Common	135	175	210	240	270	300	350	380	405	455	510	560	605	645	685
Earth	105	135	165	190	210	230	265	...	305	340	375	...	445	...	510
Clay, Hard, ...	110	145	180	210	235	265	310	335	360	405	450	490	530	570	605
Tough	90	110	135	160	180	195	230	...	270	305	340	...	410	...	475
Clay, Wet, ...	70	95	120	145	165	185	230	250	270	310	345	385	420	455	490
Sticky	55	75	95	110	130	145	173	...	210	240	270	...	330	...	383
Rock, Well	95	125	155	180	205	230	275	300	320	365	410	455	500	540	525
Blasted	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...

These figures may be increased up to 10% for units equipped with torque converters.

Table 2. Shovel Dipper Capacity in Cu Yds

Class of Material	3/8	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/4
Moist loam or light sandy clay	3.8' 85	4.6' 115	5.3' 165	6.0' 205	6.5' 250	7.0' 235	7.4' 320	7.8' 355	8.4' 405
Sand and gravel	3.8' 80	4.6' 110	5.3' 155	6.0' 200	6.5' 230	7.0' 270	7.4' 300	7.8' 330	8.4' 390
Good common earth	4.5' 70	5.7' 95	6.8' 135	7.8' 175	8.5' 210	9.2' 240	9.7' 270	10.2' 300	11.2' 350
Clay hard tough	6.0' 50	7.0' 75	8.0' 110	9.0' 145	9.8' 180	10.7' 210	11.5' 235	12.2' 265	13.3' 310
Rock well blasted	 40	 60	 95	 125	 155	 180	 205	 230	 275
Common, with rocks and roots	 30	 50	 80	 105	 130	 155	 180	 200	 245
Clay, wet and sticky	6.0' 25	7.0' 40	8.0' 70	9.0' 95	9.8' 120	10.7' 145	11.5' 165	12.2' 185	13.3' 230
Rock, poorly blasted	 15	 25	 50	 75	 95	 115	 140	 160	 195

Power shovel yardages - conditions:

1. Cu yds bank measurement per 60 min. hour with no delays
2. Suitable depth of cut for maximum effect
3. All materials loaded into hauling units 90° swing

Note. Top figures denote optimum depth of cut - bottom figures denote cubic yards per hour.

Table 3. Short Boom Dragline Performance in Cu Yds

Class of Material	3/8	1/2	3/4	1	1 1/4	1 1/2	1 3/4	2	2 1/2
Light, moist clay or loom	5.0' 70	5.5' 95	6.0' 130	6.6' 160	7.0' 195	7.4' 220	7.7' 245	8.0' 265	8.5' 305
Sand or gravel	5.0' 65	5.5' 90	6.0' 125	6.6' 155	7.0' 185	7.4' 210	7.7' 235	8.0' 255	8.5' 295
Good common earth	6.0' 55	6.7' 75	7.4' 105	8.0' 135	8.5' 165	9.0' 190	9.5' 210	9.9' 230	10.5' 265
Clay; hard, tough	7.3' 35	8.0' 55	8.7' 90	9.3' 110	10.0' 135	10.7' 160	11.3' 180	11.8' 195	12.3' 230
Clay; wet, sticky	7.3' 20	8.0' 30	8.7' 55	9.3' 75	10.0' 95	10.7' 110	11.3' 130	11.8' 145	12.3' 175

Note. Top figure denotes optimum depth of cut - bottom figure denotes cubic yards per hour (bank measure).

Table 4. Scoop Loader Production in Cubic Yards Per Hour Based on a 50 Minute Hour

SAE rated bucket capacities	Cycle time in seconds											
	20	30	40	50	60	80	100	120	140	160	180	200
1 cu yd	150	100	75	60	50	38	30	25	21	.....	.....	.....
1 1/2 cu yd	220	150	110	90	75	55	45	37	32	28	25	22
2 1/4 cu yd	338	220	168	132	110	85	68	56	48	42	38	34
2 1/2 cu yd	370	250	185	150	125	94	75	63	54	47	42	37
3 1/2 cu yd	.....	342	260	210	175	160	110	86	75	65	58	52
4 cu yd	.....	395	300	240	200	150	120	100	85	75	66	60

(2) Type and configuration of test material used.

(3) Quantity of test material loaded for each specified height of discharge.

(4) Cycle of operation or time for each loading.

d. Analytical Plan. The average load of test material discharged, in volume per cycle or volume per minute, for each specified discharge height is computed and compared with the requirements of the MN to determine the degree of conformance to specifications.

8. Capacity Rating. (Front End Loader)

a. Objective. To determine the average volume carried by the bucket of the test item.

b. Method. A test area containing stockpiled earth, sand, gravel or aggregate material is selected. The test item is loaded and prepared for taking measurements as shown in figures 1 and 2. The nominal heap of material has a 2:1 angle of repose. A heaped load is struck and the struck capacity or volume of material retained in the test item is determined by drawing a straightedge across the width of the test item with one edge of the straightedge resting on the cutting edge and the other end resting on the uppermost portion of the test item back sheet or spill guard. All appropriate measurements are determined as shown in figures 1 and 2. Lineal measurements are made in inches providing volume data in cubic inches. Struck capacity for the test item with spill guard is computed by $V_s = AW - 2/3\ a^2b$ and without spill guards as $V_s = AW$. The rated capacity for the test item with spill guards, using the 2:1 angle of repose of heaped material, is computed by $V_r = V_s + \frac{b^2W}{8} - \frac{b^2\ (a + c)}{6}$ and without spill guards by $V_r = V_s + \frac{b^2W}{8} - \frac{b^3}{24}$. V_s = struck capacity in cubic inches; A = cross-sectional area in square inches at the center of the test item (A can be determined on an accurately drawn layout by use of a planimeter or by accurately cutting a template to fit the test item profile. The template must be placed in a plane normal to the test item back sheet and equidistant from corresponding points of the test item side sheets.); W = average inside width in inches of the test item; a = height in inches of the spill guard at the center of the test item normal to the strike line; b = length of opening in inches at center of test item; V_r = rated capacity in cubic inches. This method (SAE Standard) applies primarily to regular test items having parallel sides and a cutting edge parallel to the edge of the spill guard or back sheet. Moderately clipped spill guard corners will introduce no appreciable errors. This method may not apply to irregularly shaped test items such as those with cut back side plates

or severely rounded cutting edges. Teeth or tines are presumed to have no effect on ratings.

c. Data Required.

(1) Nomenclature and description of test item.

(2) Description of materiel used.

(3) Measurements of physical dimensions of the test item and load.

d. Analytical Plan. Measurements are converted to cubic feet or cubic yards for expressing final ratings. Rated capacity is expressed in cubic yards for all sizes 3/4 cu. yd. or over, and in cubic feet for all sizes under 3/4 cu. yd. The rating is stated as "SAE Rating (Nominally Heaped)." Rated capacities are stated in increments of one cubic foot for buckets under 3/4 cubic yards, 1/8 cu.yd. increments for buckets from 3/4 to 3 cu. yd., and 1/4 cu. yd. increments for buckets over 3 cu. yds. If the calculated value falls below a given rating increment by more than 2%, the next lowest increment is used. If struck capacity is shown in addition to the SAE rating it is shown decimally to 3 significant figures.

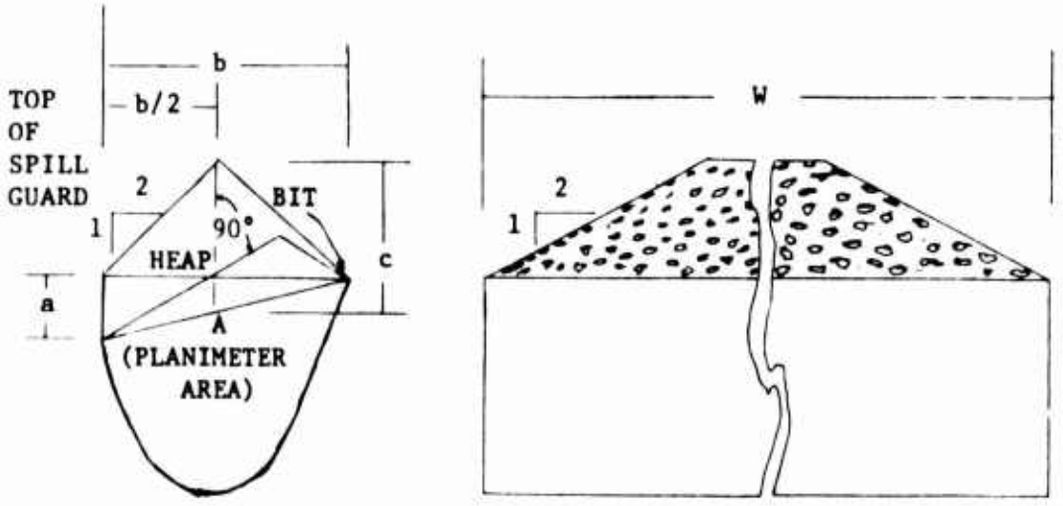

Figure 1. Buckets with Spill Guards

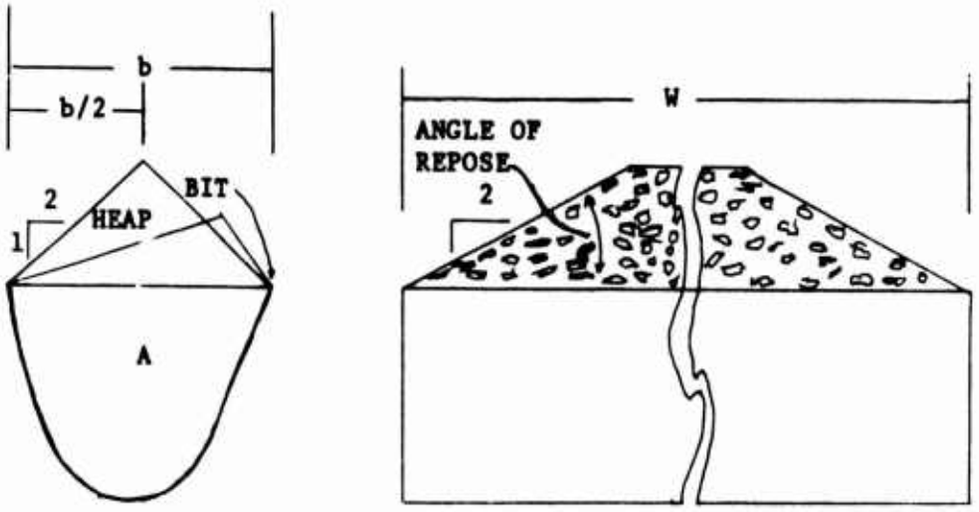

Figure 2. Buckets Without Spill Guards

Recommended changes to this publication should be forwarded to Commanding General, U.S. Army Test and Evaluation Command, ATTN: AMSTE-PA-M, Aberdeen Proving Ground, Maryland 21005. Technical information related to this publication may be obtained from the preparing activity, Commanding Officer, Aberdeen Proving Ground, ATTN: STEAP-MT-DM, Aberdeen Proving Ground, Maryland 21005. Additional copies of this document are available from the Defense Documentation Center, Cameron Station, Alexandria, Virginia 22314. This document is identified by the accession number (AD No.) printed on the first page.

APPENDIX
REFERENCES

1. AR 70-38, "Research, Development, Test and Evaluation of Materiel for Extreme Climatic Conditions."

2. USAMC Supplement 1 to AR 11-26, "Value Engineering."

3. AMCP 702-3, "Quality Assurance - Reliability Handbook."

4. HEL-STD S-1-63B, "Maximum Noise Level for Army Materiel Command Equipment."

5. MIL-STD-271D, "Nondestructive Testing Requirements for Metals."

6. MIL-STD-461A, "Electromagnetic Interference Characteristics, Requirements for Equipment", including notices 1 thru 4.

7. MIL-STD-462, "Electromagnetic Interference Characteristics, Measurement of", including notices 1 thru 3.

8. MIL-STD-810B, "Environmental Test Methods", including notices 1 thru 4.

9. MIL-L-403D, "Loaders, Bucket-Type."

10. MIL-L-14554B, "Loader, Belt-Type: Self-Propelled, Gasoline-Engine-Driven."

11. MIL-L-52385B, "Loaders, Scoop-Type, Pneumatic-Tired, Four-Wheel-Drive, Diesel-Engine-Driven", including amendment 2.

12. Society of Automotive Engineers, Inc., "1971 SAE Handbook."